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First record of a troglobitic Delphacidae in the Neotropics: *Spelaeodelphax nexus* Santos & Asche gen. nov. et sp. nov. from Brazil (Hemiptera, Fulgoromorpha)*

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Abstract

A new obligately cavernicolous planthopper species belonging to the Delphacidae was discovered in a cave in Bahia State, Brazil. As no epigean relatives could be identified so far, the species is isolated among the Asiracinae, and accordingly, a new genus *Spelaeodelphax* **gen. nov.** is erected to accommodate it. Worldwide, this discovery represents only the fourth record of subterranean Delphacidae and the second confirmed case of a cave-adapted delphacid, and the first such record in the Americas. The *Spelaeodelphax nexus* **sp. nov.** is the seventh troglobiont Fulgoromorpha recorded in Brazil. The discovery of this spectacularly troglomorphic species is yet another example of the unique diversity and ecological complexity of biological communities in Brazilian cave environments, and underlines the imperative need for the conservation and in-depth study of subterranean ecosystems.

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Keywords
Limestone caves, nymphal morphology, subterranean biodiversity, troglomorphy

Introduction

To date, worldwide, more than 70 planthopper species in five families have been explicitly reported to live in the subterranean ecosystems (Bourgoin 2024; Le Cesne et al. 2024; Hoch et al. 2025): Cixiidae Spinola, 1839 (more than 40 species), Meenoplidae Fieber, 1872 (15 species), Kinnaridae Muir, 1925 (7 species), Delphacidae Leach, 1815 (3 species), Hypochthonellidae China & Fennah, 1952 (1 species) and Flatidae Spinola, 1839 (1 species).

A new cave-dwelling planthopper species belonging to the Delphacidae was discovered during a recent expedition by the Centro de Estudos de Biologia Subterrânea (CEBS) in Brazilian caves. Subterranean species of the Delphacidae are extremely rare and have hitherto been reported exclusively from New Caledonia (Fig. 1B): the obligately cave-dwelling *Notuchus larvalis* Fennah, 1980 (Fennah 1980), and the endogean *Notuchus ninguae* Hoch & Asche, 2006, and *Notuchus kaori* Hoch & Asche, 2006 (Hoch et al. 2006). The new species described below clearly represents an evolutionary lineage separate from *Notuchus*. It thus represents the second genus and the fourth species of subterranean Delphacidae worldwide.

In Brazil, it is the seventh record of a troglobiont planthopper species; previously described cave-dwelling species belong to the Cixiidae (Hoch and Ferreira 2012; Santos et al. 2023; Santos et al. 2025) and the Kinnaridae (Hoch and Ferreira 2013, 2016). The only other troglobiont planthopper species from South America is the cixiid *Notolathrus sensitivus* Remes-Lenicov, 1992 from Argentina (Remes-Lenicov 1992; Santos et al. 2024).

The new species is described below, and a new genus is erected to accommodate it. Information on adult and nymphal morphology is provided as well as on the species distribution, ecology, and conservation status. With this discovery, the number of Brazilian delphacids is updated to 39 genera and 83 species, 29 of which are endemics.

Materials and methods

Study area

Specimens of *Spelaeodelphax nexus* sp. nov. were found in a single cave in the municipality of Carinhanha in the state of Bahia, northeastern Brazil (Fig. 1A, C, D). The cave, Lapa dos Peixes I (Fig. 2A–C), is a limestone cave of 9,320 m length. For more detailed information on habitat, see the paragraph on Ecology.

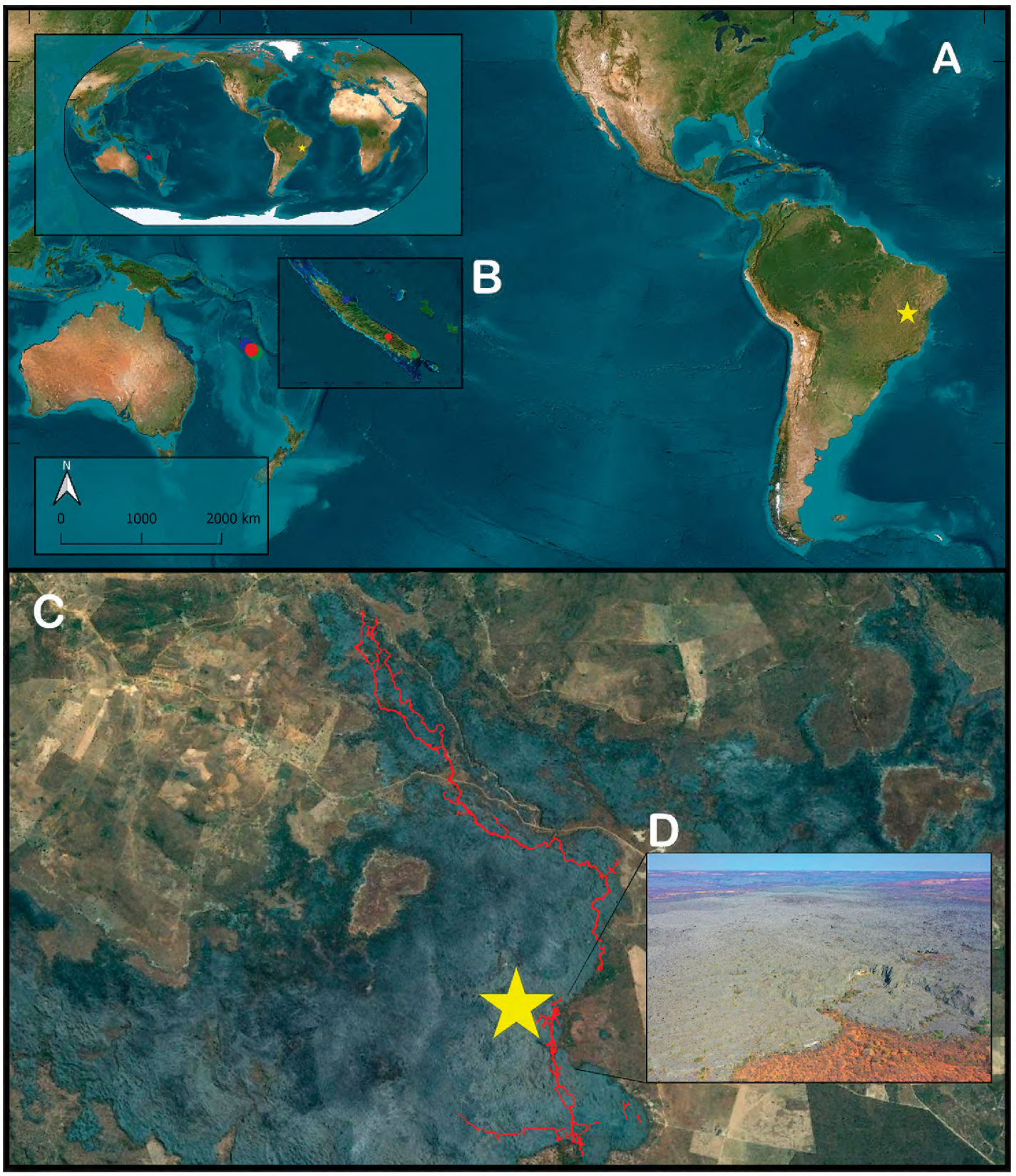

Figure 1. A global distribution of troglobitic Delphacidae; yellow-star, *Spelaeodelphax nexus* sp. nov., blue dot, *Notuchus larvalis* Fennah, 1980, red dot, *Notuchus ninguae* Hoch & Asche, 2006, green dot, *Notuchus kaori* Hoch & Asche, 2006 **B** focus on distribution of species of the genus *Notuchus* Fennah, 1980 in New Caledonia **C** outcrop of Águas Claras cave complex (red) where Lapa dos Peixes I cave, type locality of *Spelaeodelphax nexus* is located (Google earth) **D** aerial photograph of the area above Lapa dos Peixes I cave, in Carinhanha- BA (Photo: R.L. Ferreira).

Collecting and storage

Utilizing moistened brushes, specimens were collected from the substrate and placed into vials filled with 96% ethanol for conservation, i.e., by Direct Intuitive

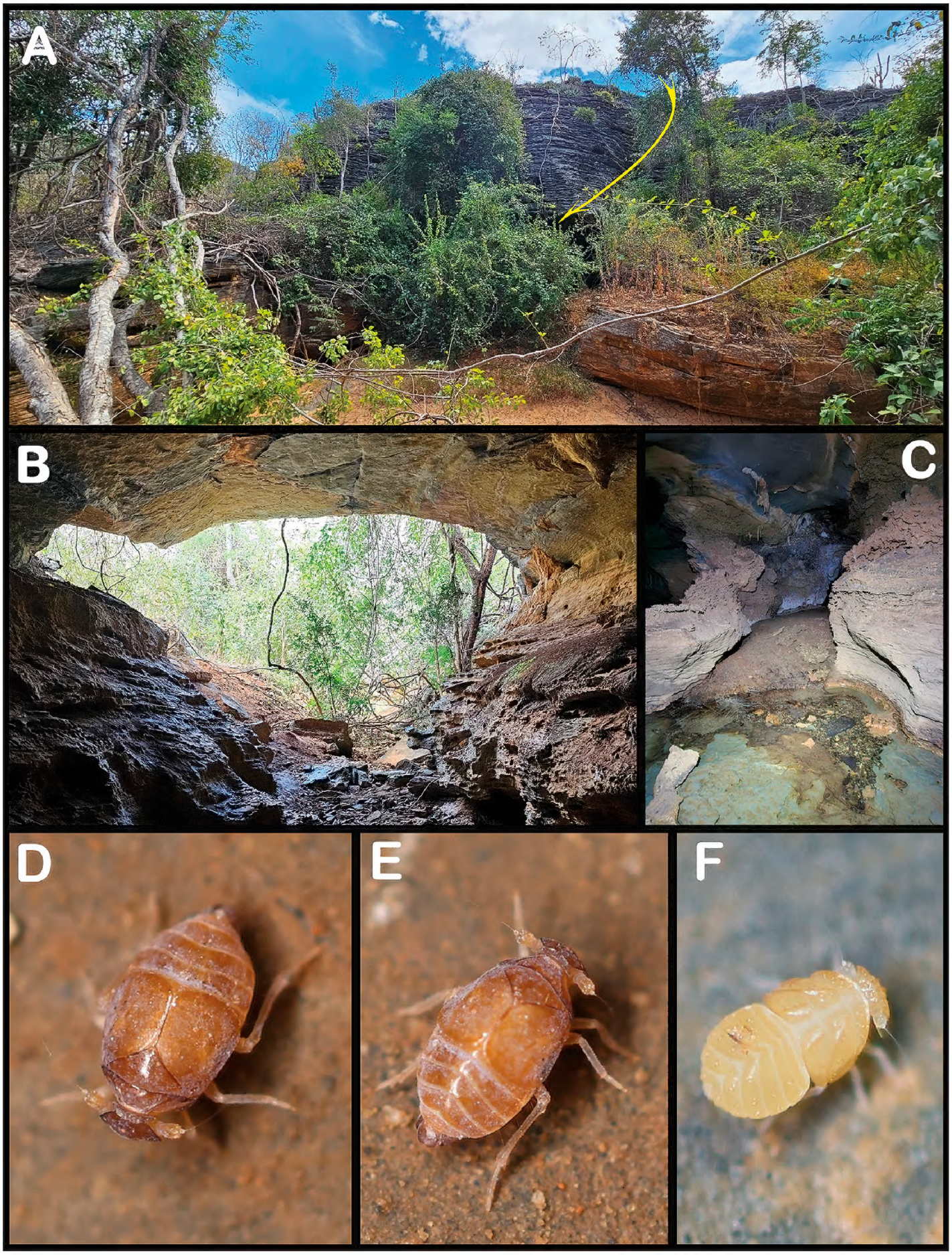

Figure 2. A Entrance of cave Lapa dos Peixes I, in Carinhanha - BA **B** entrance of cave Lapa do Peixes I, cave interior with view of entrance **C** passage of cave where the specimens were collected on soil near the water **D–F** habitus of *Spelaeodelphax nexus* sp. nov. **D, E** habitus in dorsal view of male adult **F** nymph of in dorsal view (All photos: R.L. Ferreira).

Search (DIS) *sensu* Wynne et al. (2019). Subsequently, under laboratory conditions, the collected series was segregated into individual containers, each containing 70% ethanol for long-term storage.

Preparation of male genitalia

The male genital structures were separated from the specimens with the aid of entomological pins and precision scissors. Subsequently, the genitalia were positioned in 70% ethanol in gel form to preserve their condition. This method was selected to diminish glare and improve the clarity for photographic records. After photography, the specimens were washed and stored in 70% ethanol in individual 0.5- and 2-ml tubes.

Morphological analysis and image processing

Examination of the morphological features, including measurements and imaging, were conducted using a Zeiss Axio Zoom V16 stereomicroscope, integrated with Zen 2.3 software. For consistency and accuracy in color representation, we employed the sRGB Centroids based on the ISCC-NBS Color Chart, conforming to the terminologies proposed by Centore (2016).

Scanning electron microscopy (SEM)

SEM studies were carried out at the Electron Microscopy Unit at the Institute of Biology, Humbolt-University Berlin, Germany. Specimens fixed in 96% ethanol upon collecting were trans ferred to 100% ethanol, then to a mixture (1 :1) 100% ethanol and HMDS (1,1,1,3,3,3-Hexamethyldisilazan (HMDS), and subsequently placed in HMDS, left overnight to allow HMDS to evaporate. Dried specimens were gold-coated (ca. 25 nm) by using a BAL-TEC Sputter Coater (Ag Balzers, Liechtenstein) and examined with Scanning Elecron Microscope LEO 1430 (LEO Elektronenmikroskopie GmbH; Carl Zeiss SMT AG; Oberkochen) and images were generated using the pertaining software (SmartSEM© V 06.00, Carl Zeiss Microscopy GmbH, Oberkochen).

Measurements

The following measurements were taken for this study. Body length: From the midpoint of the frons to the lower margin of the anal tube, measured along the dorsal side. Vertex length: from the leading transverse carina to the posterior edge, measured centrally. Vertex width: spanning the distance between the leading and trailing transverse carinae. Frons length: from the frontoclypeal suture directly to the leading transverse carina, measured centrally. Frons width: at its broadest section, measured from a frontal perspective. Tegmina length: from the tegulae to the outermost edge of the tegmen/forewing, measured along the dorsal side. Hind legs length: excluding coxae, of femorotibial articulation to the pretarsal claws.

Cartographic illustrations

The map was generated using QGIS 3.44 software (see Fig. 1A, B) (available in: https://qgis.org/.com). The figure 1C was obtained in Google earth (available in: https://earth.google.com/).

Image processing

The Photoshop CS6 software was used to create all the boards provided in this study. Photoroom was used to remove the stylet mouthparts in Figs 6D, 12D (available in: https://www.photoroom.com/pt-br).

Terminology

The terminology applied here are largely derived from Asche (1985). The nomenclature for tegmina venation follows that provided by Bourgoin et al. (2015).

Results

Taxonomy

Delphacidae Leach, 1815
Asiracinae Motschulsky, 1863
Asiracini Kirkaldy, 1910 (tribal placement tentative, see Discussion)

***Spelaeodelphax* Santos & Asche, gen. nov.**
https://zoobank.org/08FF76B3-E27A-4184-AAB1-36C544E1E95A

Type species. *Spelaeodelphax nexus* Santos & Asche, sp. nov.

Diagnosis. Small delphacid, habitus strongly troglomorphic: compound eyes and ocelli totally absent, tegmina strongly reduced, wings vestigial, without sexual dimorphism in the degree of troglomorphy. Females slightly larger in body size than males. *Spelaeodelphax* gen. nov. differs from all other delphacid genera by the unique combination of the following characters: vertex wide and short, median carina present; frons wider than long, median carina presents in Y-shape apically, lateral carinae not elevated. Hind tibia with lateral spines, five apical teeth, calcar small, not serrated, not reaching the midlength of basitarsus. Male terminalia, pygofer rounded in caudal view; anal segment short, semicylindrical, without process; gonostyli very short, in ventral view pincer-shaped on last third distal, lateral process sub-triangular basally; aedeagus tubular asymmetrical, shaft of the aedeagus elongated, with flattened and tubular spines, flagellum tubular developed, without spine processes.

Description. ***Structure.*** Body length 1.6–2.0 mm (male and females).

Head in dorsal view distinctly narrower than pronotum at posterior margin (0.6–0.7:1); compound eyes and ocelli totally absent. Vertex short, at posterior margin about 4 times wider than medially long, in dorsal view, apical transverse carina evanescent, slightly concave, incised medially; caudal border moderately concave, median carina evanescent; transition to frons smoothly rounded. Frons about 1.3 times wider than high, widest at level of antennal bases; no median carinae recognizable, surface smooth, shallowly

convex, lateral carinae not elevated. Frontoclypeal suture notched, shallowly arched and slightly convex towards postclypeus. Post- and anteclypeus with median carina absent, postclypeus swollen medially. Rostrum distinctly surpassing post-trochanters; distal labial segment furnished with several long bristles and a crown of numerous (14 + 2) short conical or peg-like, on ventral side one sensilla on each side located slightly basad; stylets elongate, filiformous, mandibular stylets distally split, maxillary stylets distally with a row of 4 well-spaced teeth. Antennae with scape short, ring-like; pedicel subglobose, about 3.2 times longer than scape, 1.3–1.4 times longer than wide, distally with about 10 sensory-plaques and several bristles; 3rd antennal joint relatively short, Bourgoin´s organ small but recognizable, long arista filiformous, second arista short arising laterally at base. Genae devoid of oblique carina; lamina mandibularis defined by sutures.

Thorax bearing pronotum tricarinate with 2 distinct depressions laterally, at posterior margin about 5 times wider than medially long, posterior margin shallowly concave; lateral carinae strongly divergent, sharply ridged, median carina weakly developed, evanescent distally. Mesonotum about 1.7–1.8 times wider than medially long, surface smoothly rounded, seemingly tricarinate, carinae rather weak, almost obsolete, faintly visible with particular light exposure only, lateral carinae diverging caudad, median carina only in anterior disc only. Tegmina coriaceous, surface smooth devoid of bristles, strongly reduced, attaining anterior margin of 2nd abdominal tergites; about 1.4–1.5 times longer than wide, widest at midlength, distal margin broadly rounded, almost subtruncate; venation patterns evanescent, almost absent, ScP+R anteriorly recognizable. Hindwings reduced to small and narrow elongate pads.

Legs moderately long, slender, normally shaped, devoid of obvious flattening or dilation of particular limbs; between post-trochanters and -femora on ventral side a short, densely scale-sculptured, nail-like structure (see corresponding scanning photography); such a structure, reminding of the skin of a pangolin, is present in adult Delphacidae and most other Fulgoromorpha, but is rarely referred to. Post-tibia about twice as long as post-tarsomeres combined (2.1:1), about 6 times longer than post-tibial spur; laterally with 2 spines, one near base, the other shortly basad of midlength; distally with 5 spines, increasingly longer towards outside. Postbasitarsus about 1.6–1.7 times longer than 2nd and 3rd post-tarsomers combined, about 2.5 times longer than post-tibial spur; distally with 4 equally sized stout spines in a transverse row; 2nd post-tarsomeres distally with equally small spines. Post-tibial spur (calcar) subulate, terete, distally acuminate, furnished with a few irregular bristles. Pretarsi with relatively small claws, arolium pillow-like with numerous horizontal ridges.

Abdomen bearing abdominal tergites 3–6 chevron-shaped.

Male genitalia. Pygofer moderately long, in lateral view trapezoidal, in caudal view subcircular, dorsally rather narrow, laterocaudal margins convex, ventrocaudal margin concave, medially with a short triangular process; diaphragm weakly sclerotized without a prominent armature or process; foramen for gonotyli small, flat ovate. Anal segment relatively large, hood-like, in ventrocaudal view bilobate; epiproct and paraproct rather small. Aedeagus with shaft tubular, straight, from right basal part arising a long rigid spinose process which is curved toward shaft and left side; shortly distad of

midlength of shaft on left and right side a rigid spinose process pointing almost rectangularly laterad; from apex of shaft on ventral side arising a slender, slightly sinuate and apparently mobile process which is curved ventrobasad with tip pointing right laterad; flagellum tubular, devoid of spinose processes, quartercircularly curved over dorsal side, reaching basad to nearly midlength of shaft, phallotreme apically exposed to dorsal side. Gonostyli short, slightly surpassing dorsal margin of diaphragm, in basal 2 thirds medially close to each other in a nearly straight line, inner margin subapically quarter circularly excavate, distally forming a pair of pincers with distal margin truncate.

Female genitalia. Ovipositor short and robust, ensiform, slightly surpassing tip of tergite IX and anal segment, basal part nearly at midlength of abdomen, gently curved dorsad; tergite IX ventrally broad, convex, ventromedially with a deep furrow to receive ovipositor, attaining or slightly surpassing midlength of anal segment; anal segment short, dorsocaudally semicircularly excavate, ventrocaudal margin nearly straight transverse with laterocaudally corners rounded; paraproct very short.

Etymology. The genus name is derived from the Greek word for cave (σπήλαιο). The gender is masculine.

Distribution. Brazil, Bahia state, Carinhanha municipality.

***Spelaeodelphax nexus* Santos & Asche, sp. nov.**
https://zoobank.org/7177D1F5-3F8B-4433-8435-C63D6098B507
Figs 2E, F, 3A–C, 4A–C, 5A–G, 6A–D, 7A–D, 8A–P, 9A–F, 10A–F, 11A–D, 12A–D

Type material. ***Holotype.*** • Male, Brazil, Bahia state, Carinhanha municipality, Lapa dos peixes I cave (UTM 13°48'55.6"S, 43°57'17.2"W, 23K), 07. ix. 2023 (ISLA 126058) (Fig. 1). Holotype condition: Holotype condition: Not dissected, stored in individual vials in 70% ethanol. ***Paratypes.*** • Same data as holotype except for 1 ♂ dissected, stored in individual vials in 70% ethanol (ISLA 126059) (only male genitalia), 1 ♀ (ISLA 126061) 4 nymph (ISLA 126062), and 04. vi. 2024, 1 ♂ (ISLA 126062), 1 ♂ (ISLA 126063), 1 ♂ (ISLA 126065), 1 ♂ (ISLA 126066), 1 ♂ (ISLA 126067) (dissected), 1 ♂ (ISLA 126068), 1 ♂ (ISLA 126069), 1 ♀ (ISLA 125912), 1 ♂ (ISLA 125911) (SEM).

Description. Adults. Figs 2E, F, 3A–C, 4A–C, 5A–G, 6A–D, 7A–D, 8A–P.

Diagnosis. ***Habitus.*** Small, light-colored and strongly troglomorphic delphacid devoid of compound eyes and ocelli, tegmina strongly reduced in length without recognizable venation, hind wings reduced to narrow pads. Configuration of male and female genitalia as described for the genus. For details of male genitalia see below.

Coloration (preserved specimen). As in Figs 3, 4, predominantly deep yellow (85) on head, thorax, abdomen and genitalia, some areas in pale yellow (89) principally legs, head laterally (gena) and spaces between segments, especially of the abdomen.

Body length. Male. 1.6–1.8 mm (n = 7) (Fig. 3); Female. 1.9–2.0 mm (n = 2) (Fig. 4). Configuration, shape and proportions of head, thorax and female terminalia as proposed for the genus. Some figures and measurements are provided here.

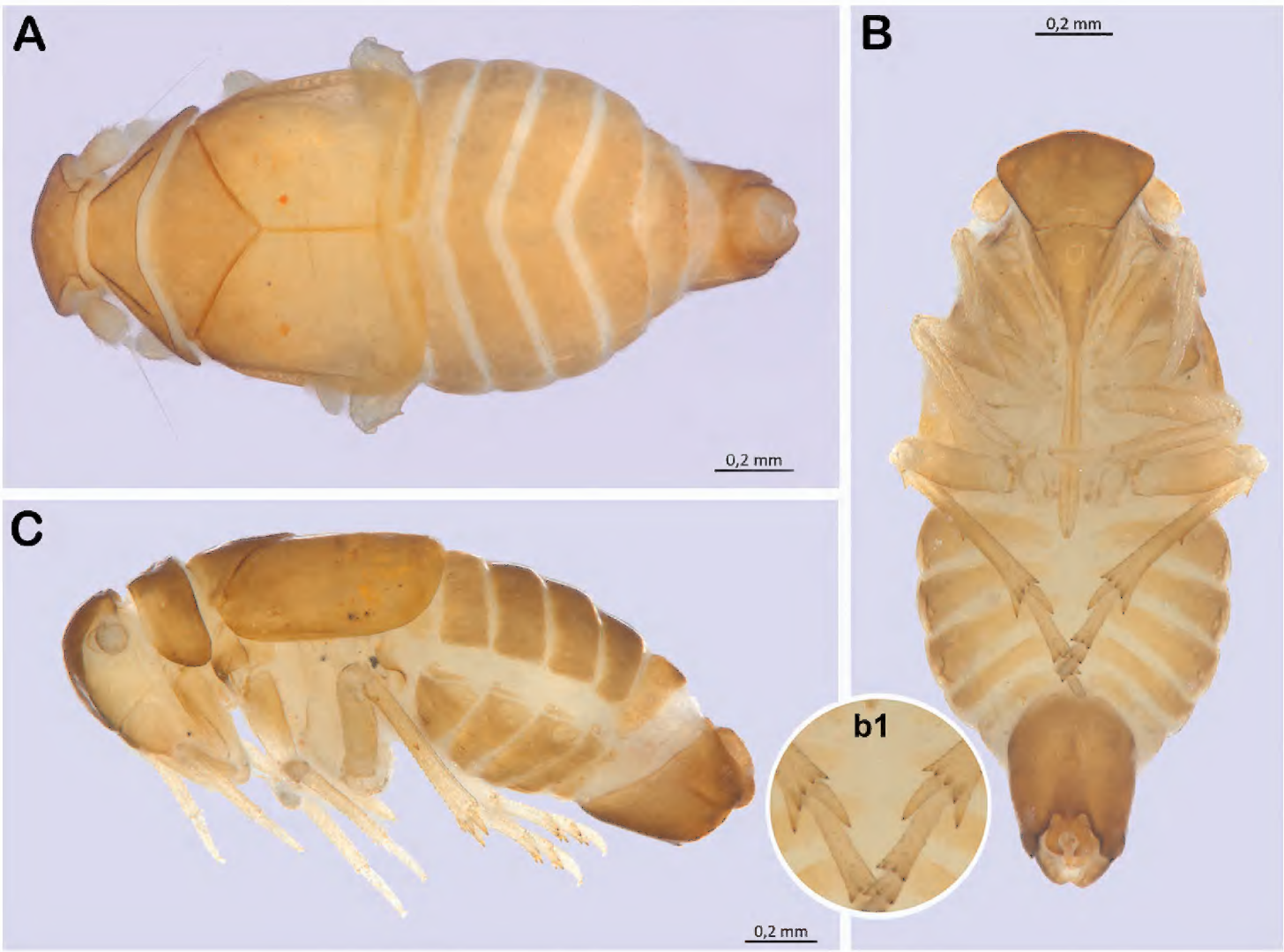

Figure 3. *Spelaeodelphax nexus* sp. nov., habitus adult male (Holotype) **A** dorsal aspect **B** ventral aspect, Inlet **b1**, detail of posterior legs with post tibial spur **C** left lateral aspect.

Head. Vertex (Figs 3A, 5A, 6A): width (0.20) length (0.04). Frons (Figs 3B, 5B, 6B, C): width (0.39) length (0.38). Antennae (Fig. 5E): Pedicel width (0.09) length (0.13).

Thorax. Pronotum (Figs 3A, C, 5A, C). Mesonotum (Figs 3A, C, 5A, C): width (0.54) length (0.30). Tegmina (forewings) (Fig. 5F, G): length (0.57). Hind legs (Figs 3B, C, 5D): length (0.91).

Male genitalia. Pygofer (Fig. 8A–D, G, H) bilaterally symmetrical; with caudal margin irregularly convex without lateral processes; in lateral view with irregular caudal margin, without lateral processes; dorsal margin slightly convex/irregular; in ventral view, margins in W-shaped with small triangular ventromedial process; in caudal view rounded, armature of diaphragm weakly sclerotized wider than tall; opening to inner chamber rounded, opening for gonostyli ovoid small approx. 3.0 times smaller than opening to inner chamber. Anal segment (Fig. 8A–D, I–J) with paired lobes slightly asymmetrical, left lobe slightly larger than right one; in caudal view margin between lobes deeply concave; epiproct and paraproct rather small. Gonostyles (Fig. 1A–C, E, F) short and slender, in lateral view pointing dorsocaudad with tip slightly surpassing laterocaudal margin of pygofer, widest in basal two thirds, with median margins opposed and close to each other, ventral and dorsal margins slightly sinuate; in distal third narrowing, forming a pair of pincers with keyhole-shaped opening between styles.

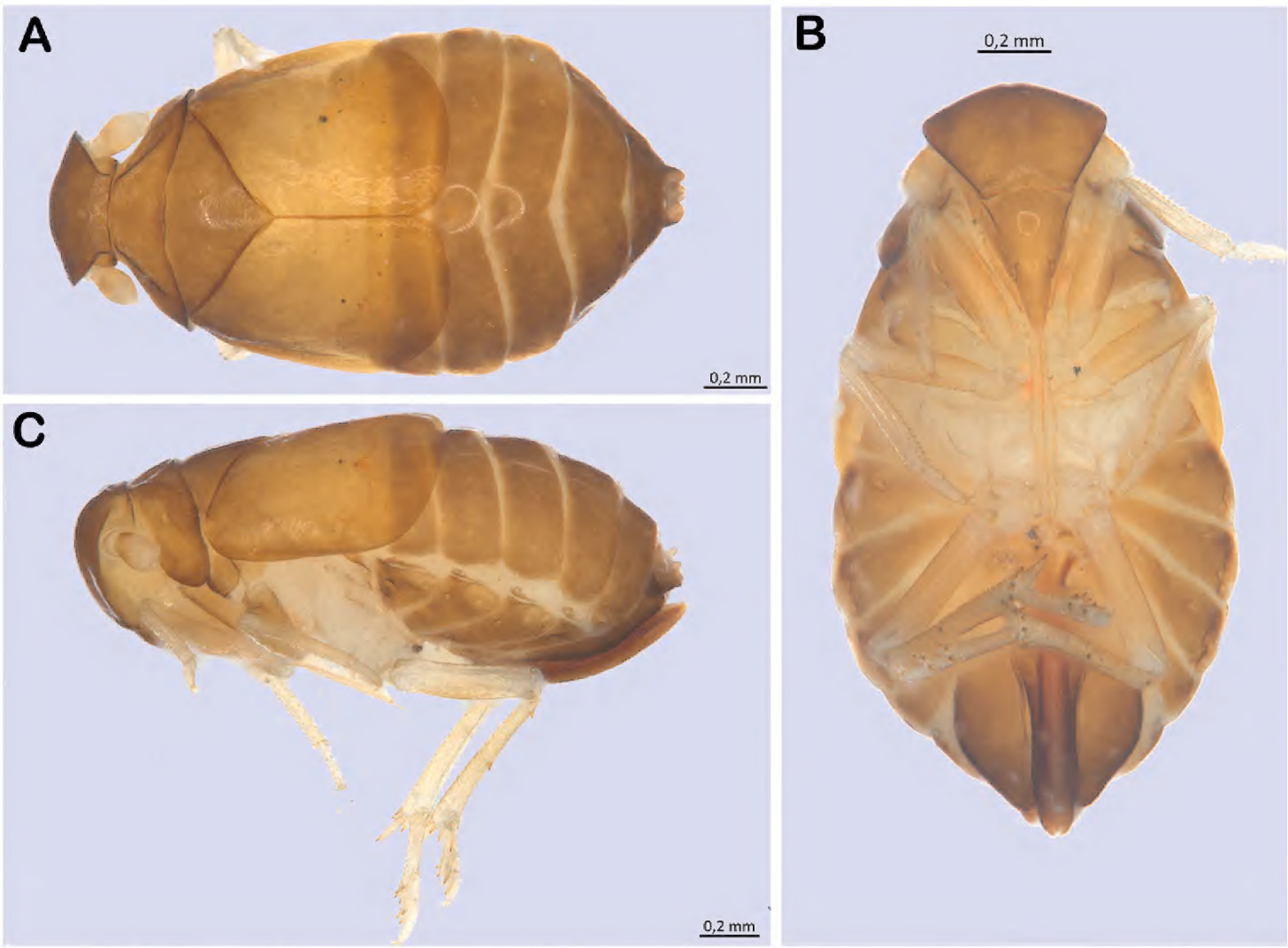

Figure 4. *Spelaeodelphax nexus* sp. nov., habitus adult female (Paratype ii) **A** dorsal aspect **B** ventral aspect **C** left lateral aspect.

Aedeagus (Fig. 8K–N) tubular, asymmetrical; shaft with four spines: a rigid spine arising right laterally near base (long, tubular, compressed ventrally, curved and directed towards apex of shaft), 2 rigid spines at about midlength on left and right side (both compressed, triangular, one short, the other slightly longer), and a movable sinuate spine arising ventrally near apex (in repose directed basally). Flagellum moderately long, slightly surpassing midlength of aedeagal shaft, laterally with serrated margin.

Female genitalia. As described for the genus.

Immatures. Figs 9A–F, 10A–F, 11A–D, 12A–D.

Nymph 5th instar. ***Body length.*** 1.9 mm (n = 3).

Habitus. Slightly dorsoventrally flattened, about twice as long as maximally wide, widest at level of forewing pads and 5th abdominal segment.

Colouration. All parts whitish to very pale yellow.

Head. Head without compound eyes, ocelli or traces of them; width at posterior margin of vertex distinctly narrower than pronotum at posterior margin (about 0.4:1). Vertex short and broad, almost pentagonal, apex anteriorly slightly produced and medially notched, at posterior margin about twice as wide as medially long, lateral and anterior margins ridged, medially a very faint longitudinal carina separating vertex in 2 halves; transition to frons broadly rounded. Frons rather wide, about 1.3 times wider than medially high, maximal width at level of antennae; lateral margins strongly convex,

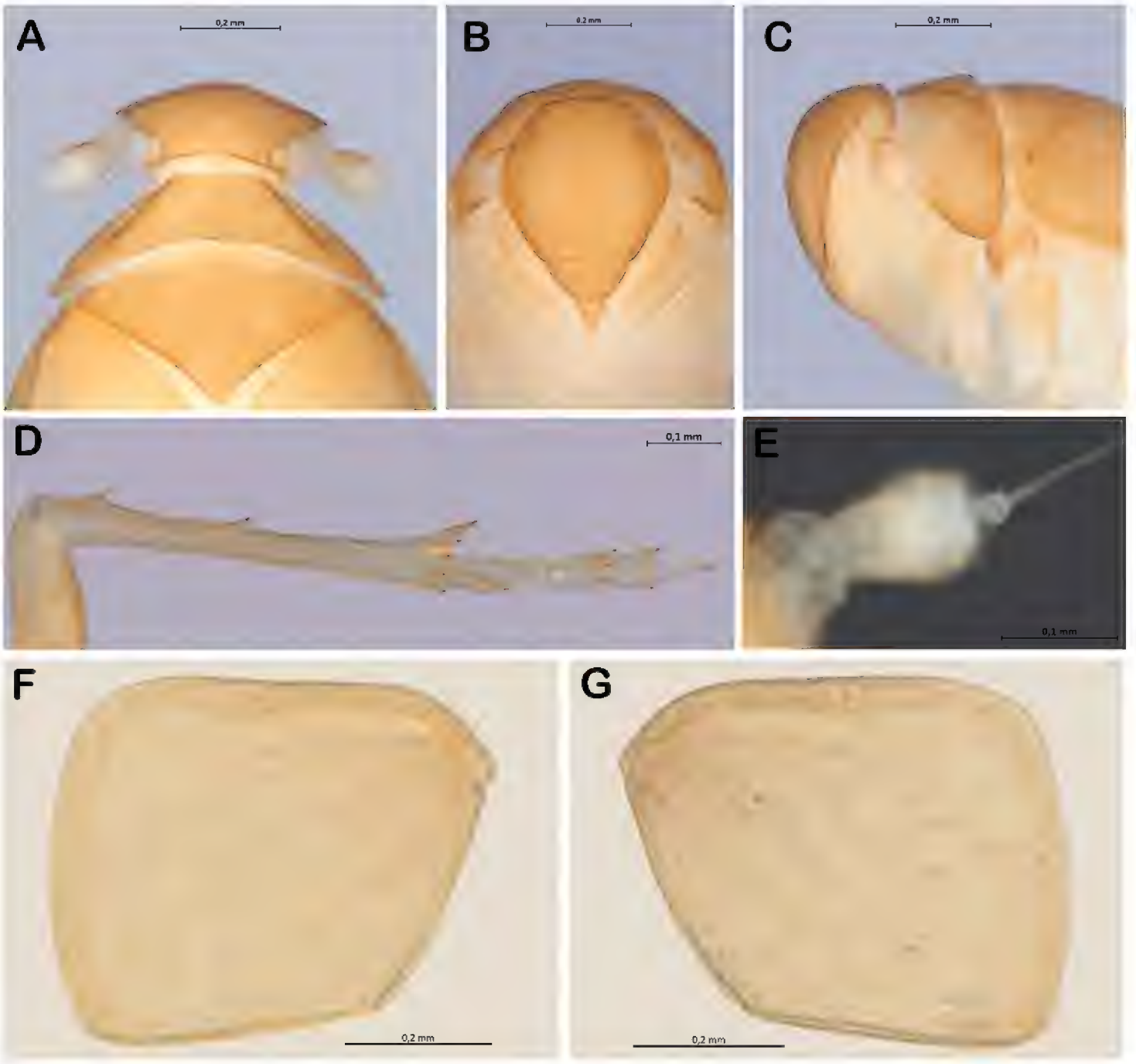

Figure 5. *Spelaeodelphax nexus* sp. nov., adult male (Holotype) **A** head and thorax, dorsal aspect **B** head, ventral aspect **C** head and prothorax, left lateral aspect **D** posterior leg, ventral aspect **E** right antenna, dorsal aspect **F, G** (Paratype iii) tegmen, **F** left lateral tegmen **G** right lateral tegmen.

paired intermediate carinae very shallowly convex, well separated from each other, converging towards apex; surface of lateral areas shallowly vaulted, of median area deeply concave; frontoclypeal margin slightly arched and notched. Head with a total of 30 sensory pits, i.e., 12 pits in lateral areas of frons and 3 pits in "preocular" area, frontal pits arranged in rows of 6 along intermediate and lateral carinae; variation: in one individual only 5 lateral pits on right side. Sensory pits on head as well as on the other tagmata oval to subcircular, from a cup-like socket at the outer margin arising a seta which is exposed horizontally over the pit without attaining lateral or opposite margins; seta distally knob-like dilated. Post- and anteclypeus shallowly vaulted, smooth, devoid of carinae, post- and anteclypeus separated by a transverse notch. Rostrum distinctly surpassing post-trochanters; tip of rostrum as in adults. Antennae short, scape ring-like; pedicel about 4 times longer than scape, subglobose, distally with about 10 sensory-

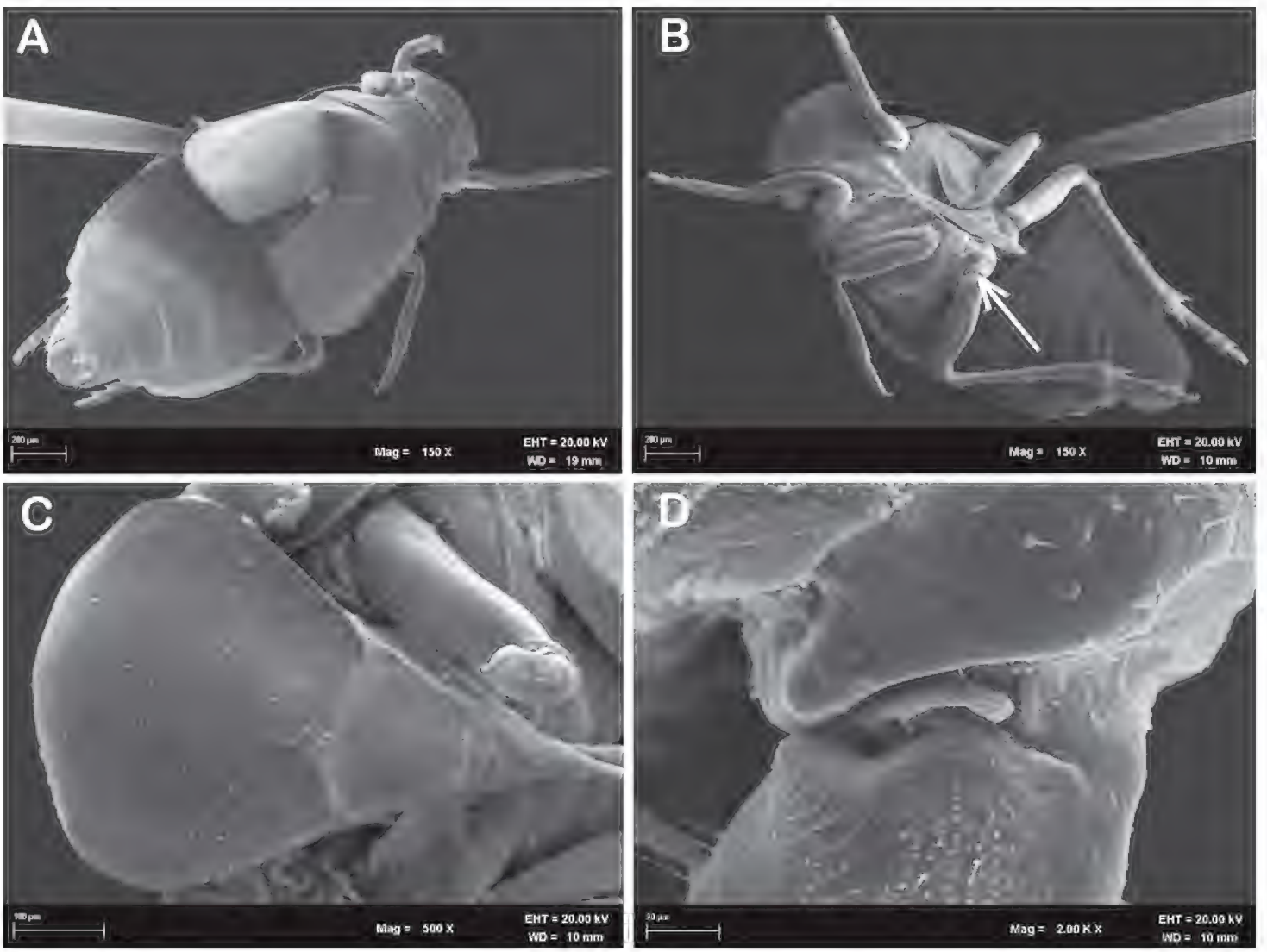

Figure 6. *Spelaeodelphax nexus* sp. nov., male, SEM **A** habitus, dorsal aspect **B** same, ventral aspect, arrow: « pangolin »-like structure (see also Fig. 6D, and description of the genus) **C** head, ventral aspect **D** close-up of « pangolin »-like structure.

plaques consisting of a crown of 3–4 longer finger-shaped processes arising from a common socle and 4–5 short rigid spines at base. 3rd antennal joint ("flagellum") distinct, knob-like, about 0.25 times shorter than pedicel, surface with 2–3 transverse wrinkles, distally continuing in a long arista ("first projection" *sensu* Shi and Yang 1996) and a short peg-like process or arista ("second projection" *sensu* Shi and Yang 1996), both with surface wrinkled; dorsally at distal margin of the 3rd antennal joint above the bases of the aristae a distinct Bourgoin´s organ consisting of about 20 slender finger-shaped processes forming a distally converging crown. Genae devoid of oblique carina, antennal bases large, subcircular, lamina mandibularis not defined by sutures, distally filiformous.

Thorax. Pronotum broad and short, about 5.4 times wider than long in middle line, medially slightly shorter than vertex (0.8–0.9:1); posterior margin straight transverse; medially a membraneous cleft, no ridged carina; dorsolateral carinae oblique, ridged, reaching from anteromedian corner of disc towards lateral posterior margin, dorsal area of disc along carina with 4 sensory pits; lateral lobes at posterior and ventral margin with a total of 4 sensory pits; surface of disc very shallowly concave, nearly plane, surface of lateral lobes slightly convex. Meso- and metanotum medially divided by a longitudinal membraneous furrow, no median carina.

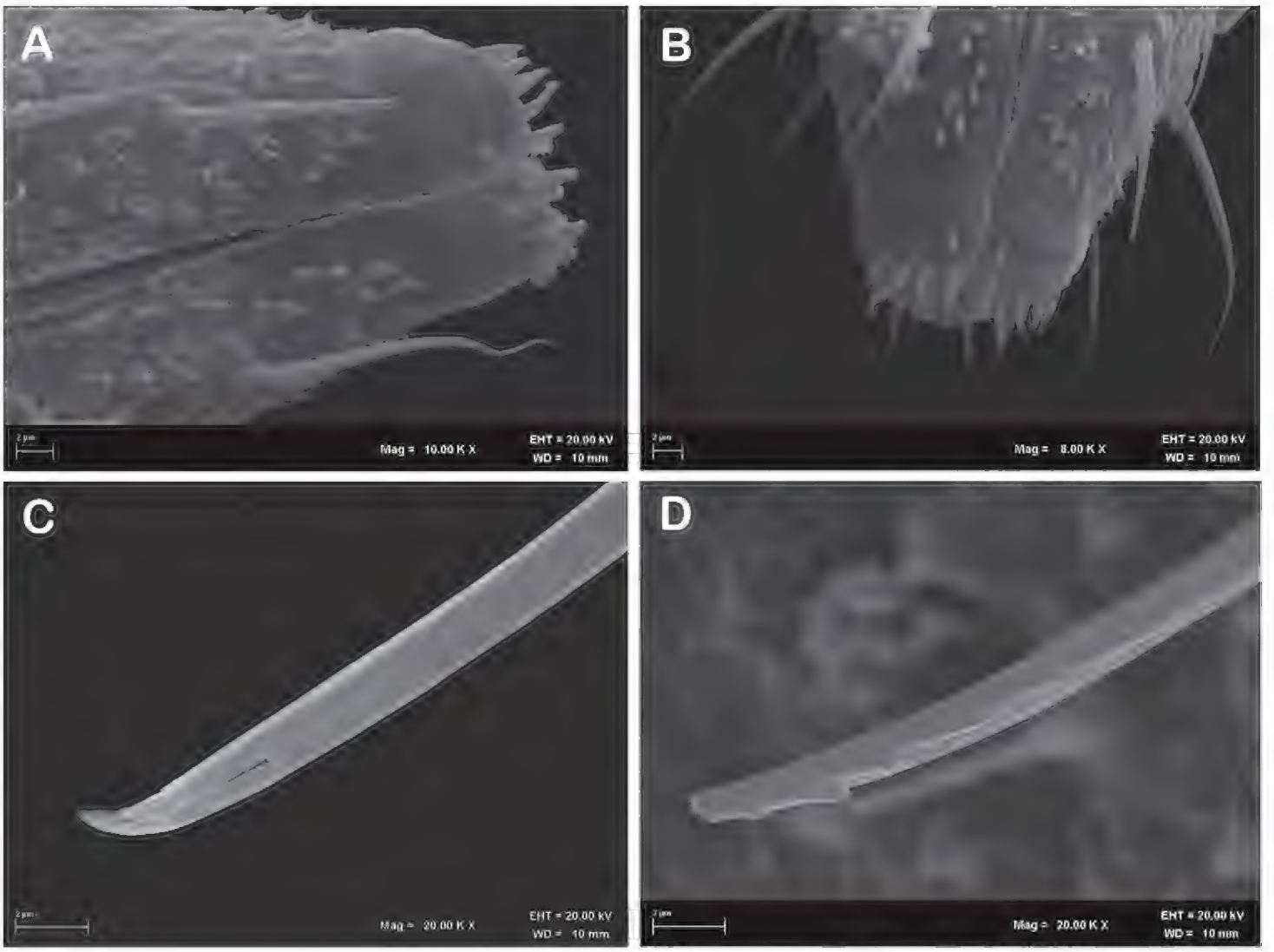

Figure 7. *Spelaeodelphax nexus* sp. nov., male, mouthparts **A** tip of rostrum, dorsal aspect **B** sensillae at tip of rostrum **C** mandibulary stylet **D** maxillary stylet.

Mesonotum approximately 3.8–4 times wider than medially long, medially about twice as long as pronotum; posterior margin shallowly concave, at lateral discal carina almost rectangularly bent inwards; disc narrow, lateral discal carina diverging laterocaudad, attaining posterior margin; mesonotum with a total of 16 sensory pits; mediad along discal carina 2 sensory pits, laterad of carina close to posterior margin another sensory pit; forewing pads large, slightly surpassing midlength of hindwing pads; pads sublaterally at posterior margin with a short ridge and a long subcostal carina; forewing pads with a single pit laterad of sublateral ridge, 2 pits at distal margin and 2 pits between subcostal and costal margin. Metanotum about 3.5 times wider than medially long, medially about as long as mesonotum, posterior margin oblique with pads rounded, attaining anterior margin of first abdominal tergite; disc plane, narrow, lateral discal carina straight, slightly diverging caudad, laterad along carina 2 sensory pits. Legs moderately long, slender, normally shaped, without significant dilation or flattening of particular limbs. Pro- and meso-femora at outer distal margin with a short tooth-like protuberance; pro- and mesotarsomeres 2-jointed with 1st tarsomere rather short, scale-like; post-tarsomeres 3-jointed. Post-trochanters medially with a narrow row of 10 parallel ribs forming a cog-wheel structure. Post-femora anteriorly at outer side with a small knob-like protuberance. Post-tibiae about twice

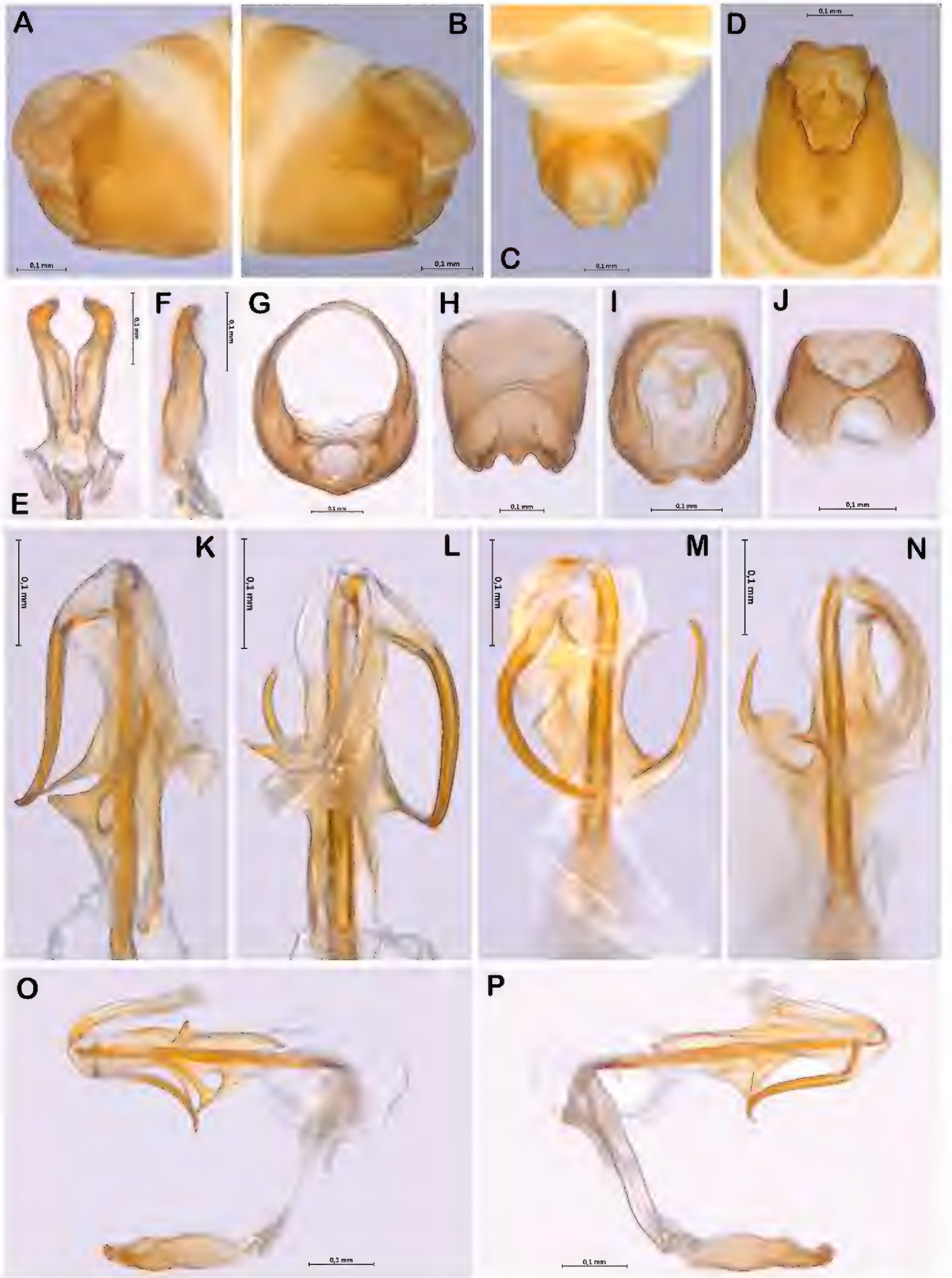

Figure 8. *Spelaeodelphax nexus* sp. nov., male genitalia (Paratype i) **A–D** genital capsule **A** right lateral aspect **B** left lateral aspect **C** dorsal aspect **D** ventral aspect **E, F** gonostyli **E** ventral aspect **F** right gonostyli in right lateral aspect **G, H** genital segment **G** caudal aspect **H** dorsal aspect **I, J** anal segment **I** dorsocaudal aspect **J** ventrocaudal aspect **K–N** Aedeagus **K** right lateral aspect **L** left lateral aspect **M** ventral aspect **N** dorsal aspect **O, P** aedeagus, connective and gonostyli *in situ* **O** right lateral aspect **P** left lateral aspect.

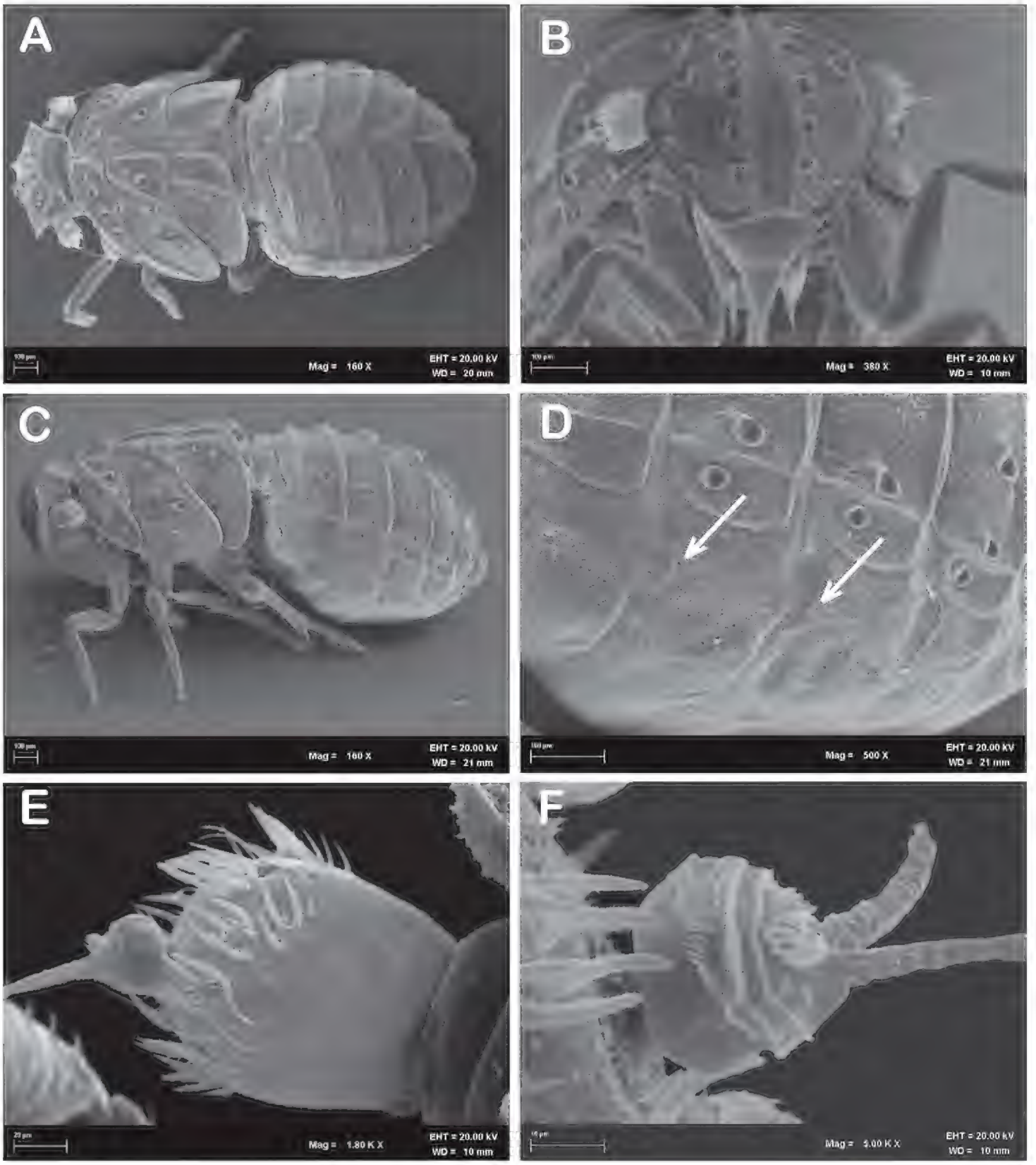

Figure 9. *Spelaeodelphax nexus* sp. nov., V. instar nymph, SEM **A** habitus, dorsal aspect **B** head, frontal aspect **C** habitus, left lateral aspect **D** detail of abdomen, lateral aspect, with stigmata (arrows) **E** antenna, pedicel and 3rd antennal joint **F** 3rd antennal joint with aristae and Bourgoin´s organ.

as long as post-tarsomeres combined, laterally with 2 small spines, one near base, the other distinctly basad of midlength; distally with 5 coarse spines and a short post-tibial spur. Postbasitarsi only little longer than 2nd and 3rd post-tarsomeres together, about 3 times longer than post-tibial spur; postbasitarsi distally with 4, 2nd post-tarsomeres with 3 stout spines in a transverse row, 2nd post-tarsomeres relatively short. Pretarsi with aroliae very large, pillow-like with several longitudinal ribs, lateral claws short. Post-tibial spur subconical, terete, with a few irregularly ordered bristles.

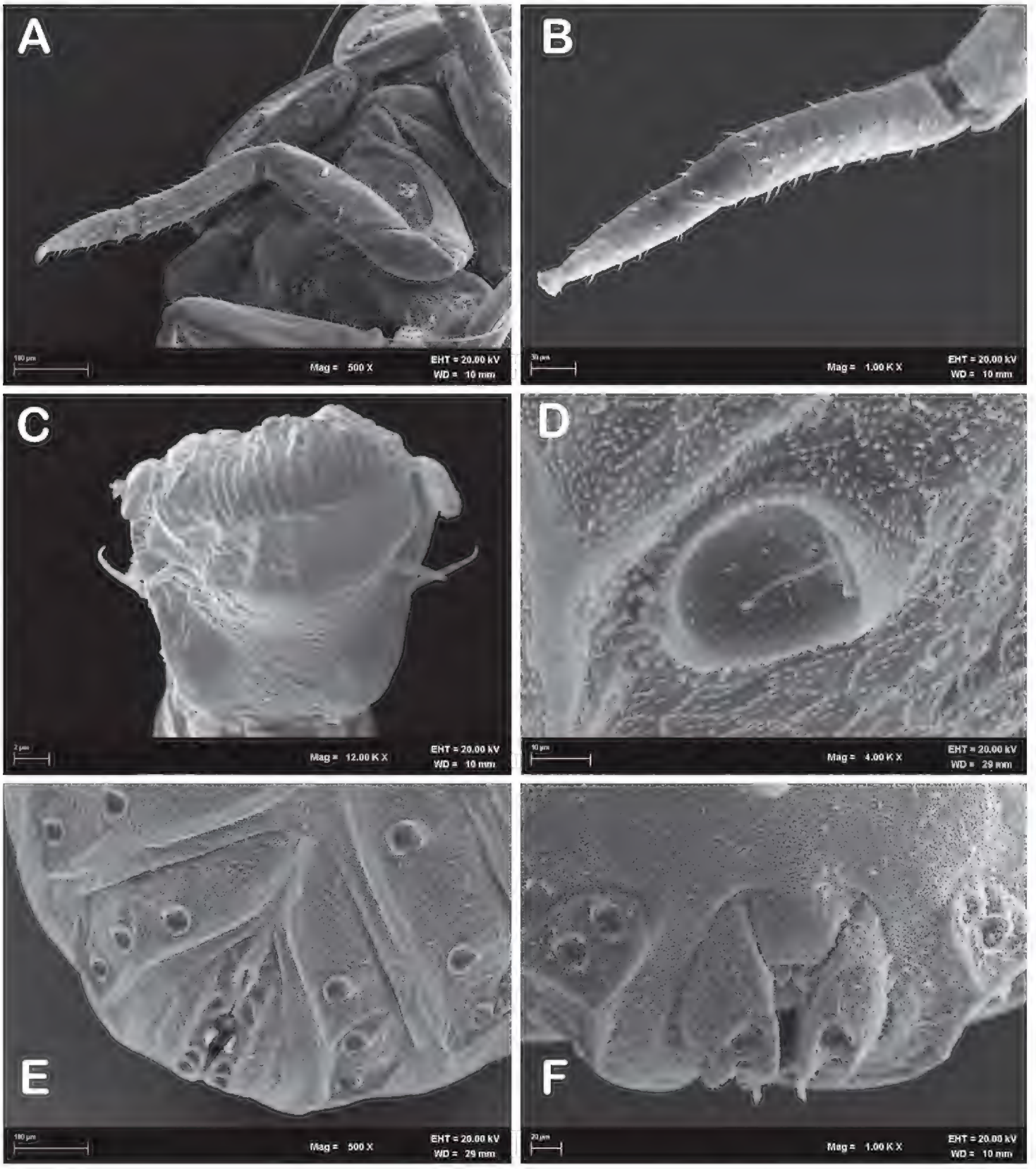

Figure 10. *Spelaeodelphax nexus* sp. nov., V. instar nymph, SEM **A** right middle leg, ventral aspect **B** tibia and tarsus of right middle leg, ventral aspect **C** pretarsus of right middle leg, ventral aspect **D** nymphal sensory pit on lateral abdomen **E** *Anlagen* of genital capsule, dorsal aspect **F** same, ventral aspect.

Abdomen. Tergites mediodorsally incised, distal tergites with sharply ridged crest, no wax-plates on tergites; tergites I–III devoid of sensory pits; tergite IV with a single sublateral pit, extralateral area devoid of pit; tergite V with a sublateral and a lateral pit, tergites VI–VIII with a subdorsal, a sublateral and a lateral pit, extralateral areas V–VIII anteriorly with a single pit; an intermediate or sublateral carina of tergites missing, only on tergite VIII a short sublateral ridge; 9th abdominal segment with a single dorsal and 2 ventrocaudal sensory pits; in the late 5th instar males the outline of the pygofer

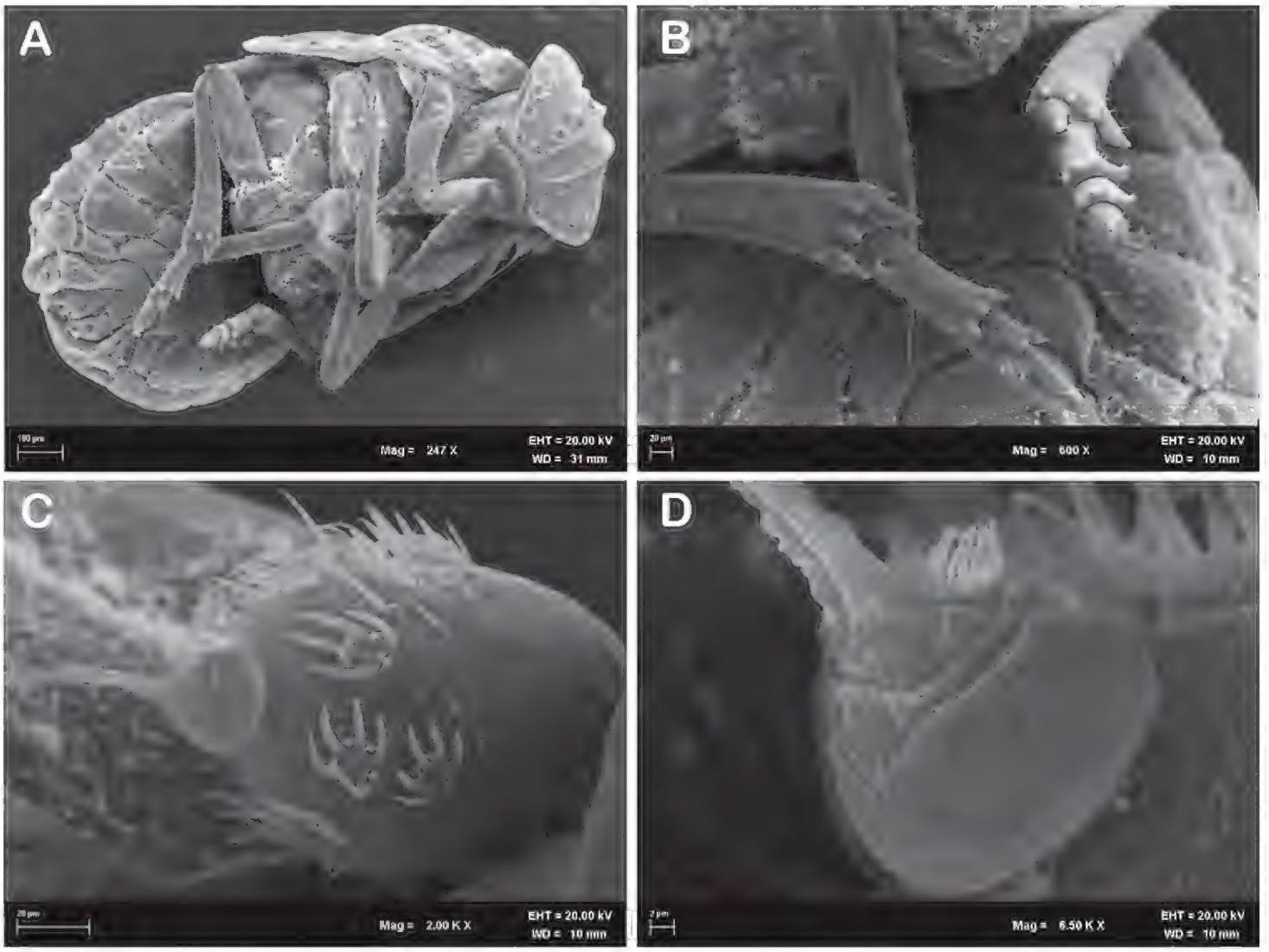

Figure 11. *Spelaeodelphax nexus* sp. nov., IV. instar nymph, SEM **A** habitus, ventral aspect **B** posterior legs, ventral aspect **C** antenna, pedicel and 3rd antennal joint **D** 3rd antennal joint with Bourgoin´s organ.

and lateral anal combs, and in the females the developing of paired gonapophyses of the ovipositor are visible. In the individuals examined the dicision for a particular sex appears difficult as there are on one hand clearly recognizable paired structures which may be interpreted as gonapophyses, on the other hand mediolateral protuberances which may be interpreted as anal combs. Stigmata are present in the intersegmental fold between extralateral parts of tergites and sternites, mostly located anteriorly.

Nymph 4th instar. ***Body length.*** 1.25 mm (n = 2).

Habitus, coloration and equipment with sensory pits as in 5th instar nymphs; rostrum relatively longer, attaining anterior margin of 5th sternite; pedicel with surface smooth, distally as in 5th instar with about 10 sensory-plaques; 3rd antennal joints relatively larger, with 2 distinct transverse wrinkles with serrate margin; Bourgoin´s organ large, consisting of about 20 long finger-shaped processes arising from a common plate. In mesonotum forewing pads shorter, attaining anterior margin of metanotal hindwing pads, posterior margin shallowly concave. Legs in shape, proportions and spine-configuration of hindlegs as in 5th instar, cog-wheel structure of post-trochanters with about 10 parallel ribs. Anlagen of male and female genitalia as in 5th instar.

Nymph 3rd instar. ***Body length.*** 0.98 mm (n = 1).

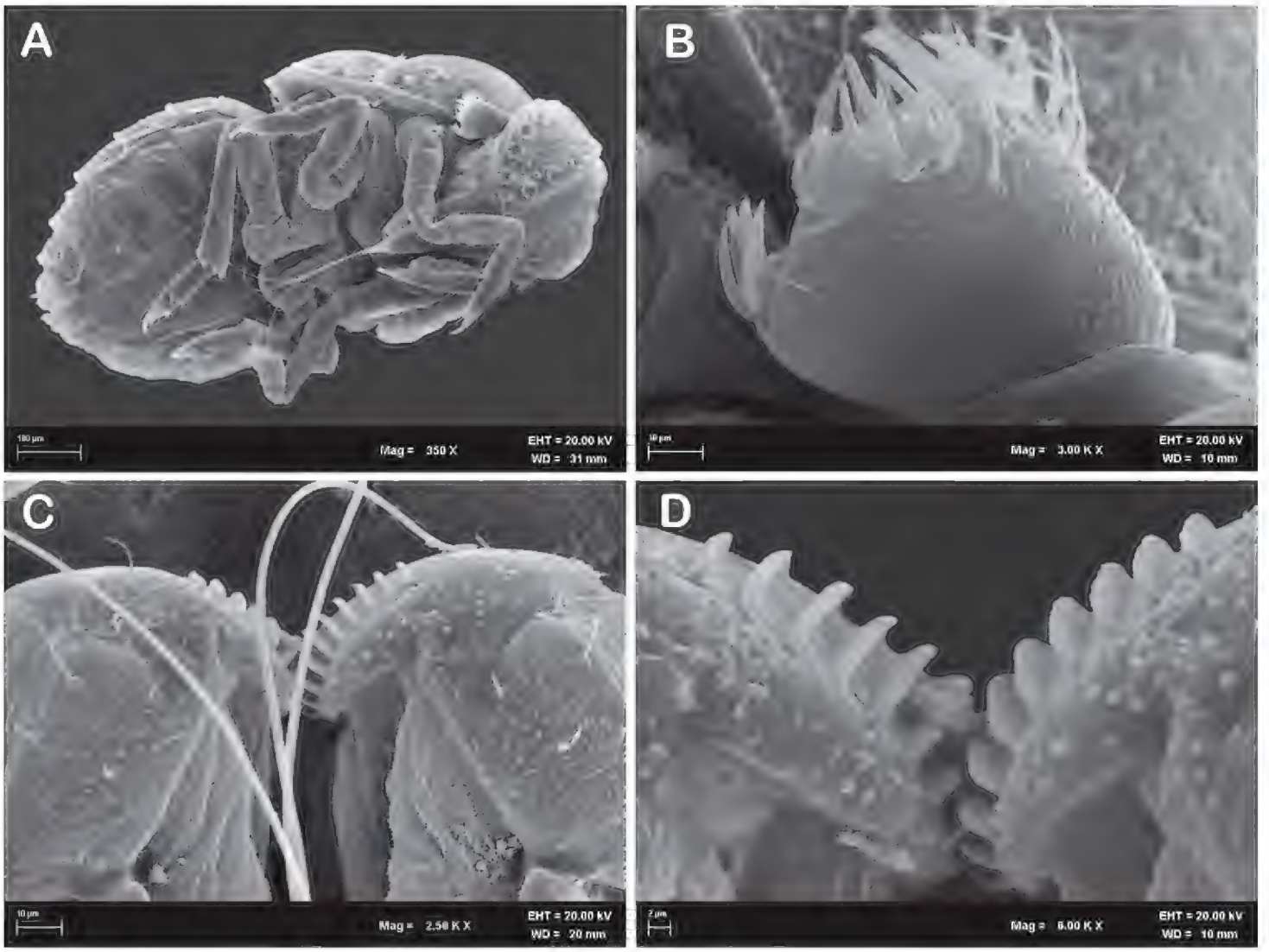

Figure 12. *Spelaeodelphax nexus* sp. nov., III. instar nymph, SEM **A** habitus, ventral aspect **B** antenna: pedicel and 3rd antennal joint **C** cog-wheel structure of post-trochanters, with overlaying mouthpart stylets, ventral aspect **D** same cog-wheel structure, focused and without overlapping mouthpart stylets, ventral aspect.

Habitus, coloration, proportions, number and arrangement of sensory pits as in 5th and 4th instar nymphs; rostrum long as in 4th instar; pedicel 3.4 times longer than scape (in 4th and 5th instar about 4 times longer), distally with about 6 sensory-plaques (10 in 4th and 5th instar); 3rd antennal joint relatively large with surface finely sculptured, Bourgoin´s organ distinct, shaped as in 4th and 5th instar. Legs with cog-wheel structure of post-trochanters as in 5th and 4th instar with 10 parallel ribs; all tarsi 2 segmented, in second post-tarsomeres limitation of later separation marked by 2 small spines on ventral side; lateral margins of post-tibiae without spines, or spines vestigial; post-tibial spur rather small, developed as rigid cone. *Anlage* for genital structures faint.

Etymology. The species epithet is a noun in apposition treated as indeclinable. It is derived from the 1994 movie «Star Trek: Generations», in which *Nexus* refers to a place of bliss that connects different points in space-time, acting as a link between distinct realities. The gender is masculine.

Distribution. The species newly described herein was collected in a cave located in the Serra do Ramalho, a vast karstic province situated in southwestern Bahia, Brazil. This region lies within the São Francisco Carbonate Supergroup, particularly the Bambuí Group, and is renowned for its thick limestone deposits and complex subterranean

networks (Auler et al. 2001). The karst extends over roughly 12,000 km², framed by the Carinhanha and Corrente rivers, which are important tributaries of the São Francisco River, forming one of the largest continuous carbonate outcrops in eastern South America.

The lithostratigraphy of Serra do Ramalho is dominated by the Sete Lagoas and Lagoa do Jacaré formations, which are composed mainly of calcilutites, calcarenites, calcirudites, and dolomitic facies (Ferreira et al. 2023). These rock assemblages have given rise to an impressive array of geomorphological features, including extensive cave systems, dolines, sinkholes, and subterranean drainage networks. Further details on the geological framework and hydrogeological dynamics of the region are available in Ferreira et al. (2023).

Climatically, the area is classified as tropical savanna (Aw, Köppen system). The local regime is characterized by a pronounced dry season extending from March to October, followed by a shorter wet season. Annual precipitation averages approximately 640 mm, while mean temperatures hover near 26 °C (Alvares et al. 2013; INMET 2018). This seasonal variability strongly influences the ecological processes of the karst, shaping both the surface vegetation and the subterranean communities.

Ecological associations, habitat characteristics, and potential threats concerning the new species are discussed in the section "Ecological Remarks" below.

Ecological remarks. *Spelaeodelphax nexus* sp. nov. is currently restricted to a single site within the Água Clara Cave System (ACCS), a large and linear subterranean complex developed in calcarenitic strata of the Sete Lagoas Formation (Fig. 1C). The system comprises four major caves arranged along a hydrological continuum: Gruna da Água Clara (13,880 m), Gruna dos Índios (510 m), Lapa dos Peixes I (9,320 m; Fig. 1C, D), and Lapa dos Peixes II (2,100 m). Recognized as the richest tropical subterranean system in terms of obligate cave fauna, the ACCS harbors at least 52 troglobitic and stygobitic species (Ferreira and Souza-Silva 2023; Vaz et al. 2025).

The new species was discovered exclusively in Lapa dos Peixes I (Fig. 2A–C), where airflow between two distant entrances creates a pronounced seasonal microclimatic gradient. While much of the conduit experiences severe desiccation during the austral winter, the sector where the population occurs remains permanently humid owing to a permanent water body. This microhabitat is among the most environmentally stable zones of the entire system and sustains the highest concentration of troglobitic taxa within the ACCS (Ferreira and Souza-Silva 2023).

Within this humid conduit, *S. nexus* was consistently found in association with root mats that penetrate the cave through fissures in the rock, descending from a small upper conduit connected to the main passage where the water body occurs (Fig. 2C). All individuals were observed either directly on the roots lying along the cave floor or in their immediate vicinity, occasionally sheltered beneath rocks. In contrast, root tufts hanging from the ceiling or walls did not harbor specimens. This apparent preference for floor-level roots may be related to the higher moisture content of substrates in this area, compared with the relatively drier walls and ceiling. Both adults and nymphs were documented in successive surveys (Fig. 2D–F), suggesting continuous reproduction throughout the year. Although the host plant species remains unidentified, precluding an evaluation of trophic specialization, it is clear that the species depends on these roots as a food resource.

The apparent confinement of *S. nexus* to a single, permanently humid conduit suggests extreme micro-endemism and high vulnerability to environmental fluctuations or disturbance.

Although this species likely occurs in inaccessible crevices (mesocaverns), we currently lack precise data on the permeability of the Karst in this locality. In addition, the exact distance between the surface and the conduit where the samples were collected near the roots cannot be precisely determined but was estimated to be at least 50 meters. Surrounding landscapes exert considerable pressure on the ACCS and are threatened. Widespread deforestation (Fig. 13A) driven by agriculture and charcoal production (Fig. 13B) has already altered surface processes near cave entrances, reducing organic inputs, increasing erosion, and accelerating sediment deposition within caves. Such changes homogenize substrates and degrade aquatic and terrestrial microhabitats, disproportionately impacting highly specialized subterranean fauna (Pellegrini et al. 2016; Cardoso et al. 2022).

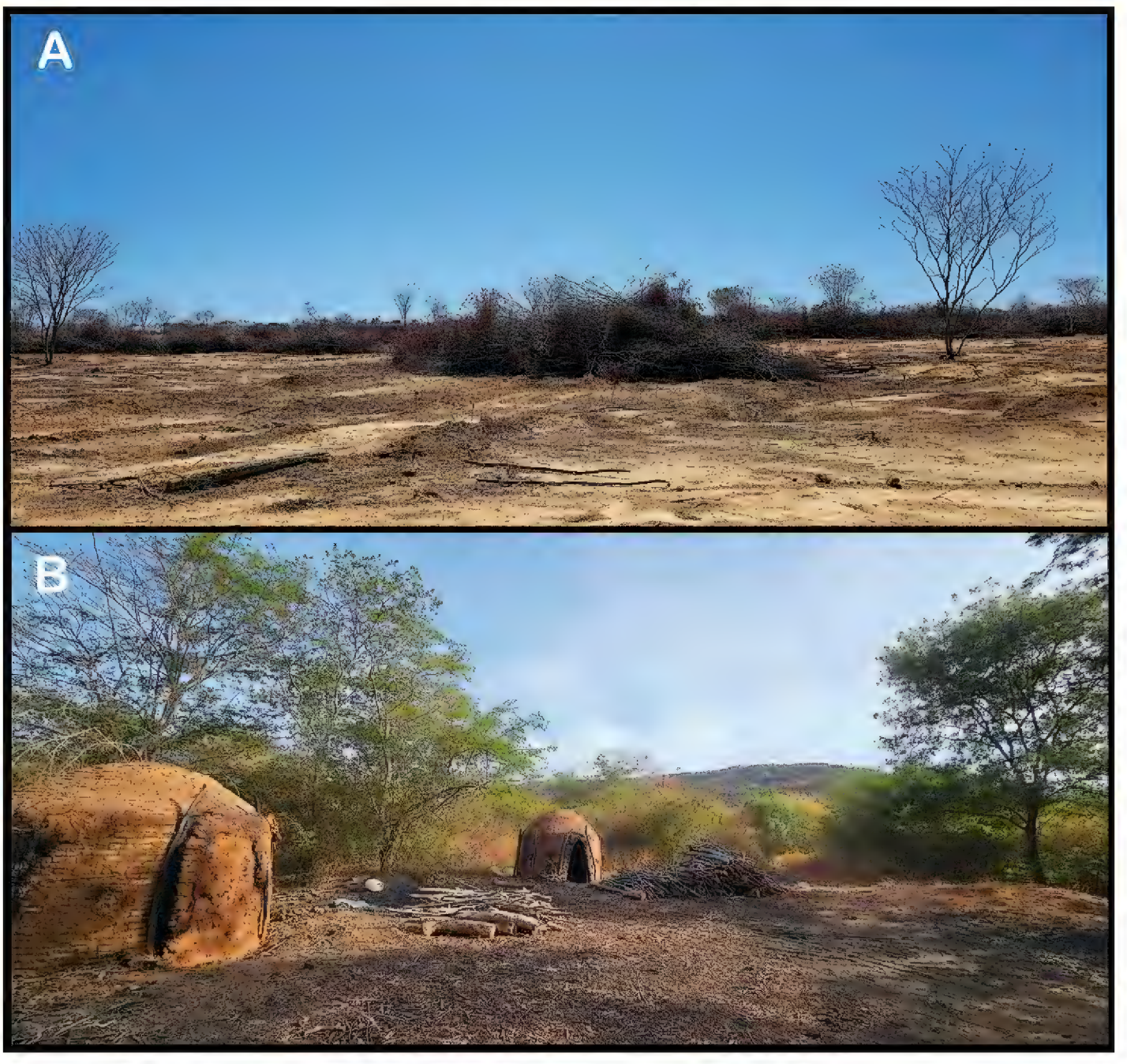

Figure 13. Principal threats of habitat of *Spelaeodelphax nexus* sp. nov. **A** deforestation of the area of influence of the Lapa dos Peixes I cave for charcoal production **B** charcoal ovens used to burn plant material removed from the cave's surroundings. (Photos: R.L. Ferreira).

Given both the exceptional biodiversity of the ACCS and the restricted distribution of *S. nexus*, the implementation of urgent conservation measures is imperative. We strongly recommend the creation of a legally protected conservation unit that encompasses not only the subterranean network but also the surrounding karst landscape and its contributing catchments. Protection of this broader system under strict environmental regulations is essential to preserve ecosystem integrity and to ensure the persistence of this newly described species along with the remarkable cave-restricted assemblages of the Água Clara Cave System.

Discussion

Neotropical Delphacidae

Delphacidae is the second largest family of Fulgoromorpha and comprising approximately 67 genera and 304 species in the Neotropical region (Bourgoin 2025). In Brazil, hitherto 82 species have been documented, 28 of which are endemic (Bartlett et al. 2025), representing 38 genera, plus the new taxon described here. Most species were described during the 19th century, and over the last two decades, only five species belonging to four genera have been described from Brazil (Bartlett and Deitz 2000; Bartlett 2010; Remes Lenicov and Varela 2014; Bellis and Donaldson 2016). Although the new genus described in this study was erected to accommodate a single species, this discovery represents a significant contribution to the understanding of Neotropical delphacid diversity, ecology, and evolution.

Ecological classification

Spelaeodelphax nexus sp. nov. displays several troglomorphic characters: absence of compound eyes and ocelli, strongly reduced tegmina and vestigial wings, and light body coloration. Although there is no information on the behavior of the species, it is certainly unable to fly. The phenotypical configuration of eyes and wings suggests that it is restricted to the subterranean environment and likely to complete the entire life cycle underground. According to the criteria provided by Sket (2008), and more recently by Howarth and Moldovan (2018a, 2018b), we regard *Spelaeodelphax nexus* as an obligate cavernicole, or troglobiont.

Tribal placement

A recent review of the New World Ugyopinae and Asiracinae has been published by Barringer and Bartlett (2011). Within the New World Asiracinae there is no generic equivalent to *Spelaeodelphax* - as far as recognizable in a strongly modified troglomorphic taxon - which displays a convex frons without clearly determinable median carina (see SEM images), a tricarinate pronotum and apparently a tricarinate mesonotum with carinae feeble or evanescent, lateral carinae divergent. Such a configuration is not

present in Tetrasteirini (mesonotum quadricarinate), Idiosystatini and Platysystatini (mesonotum pentacarinate). A tricarinate configuration is found in the Afrotropical genus *Fennasiraca* Asche; however, the differences in characters of external and genitalic morphology do by no means support the assumption of a closer relationship. Thus, tribal placement is problematic: the genus remains isolated. For the time being we suggest treating this genus as member of the tribe Asiracini. The only other New World genus currently in Asiracini is *Copicerus* Swartz; but in this genus the mesonotal carinae are obsolete, and the head configuration with conspicuously elongate and flattened antennae does not provide any indication of a closer relationship with *Spelaeodelphax* gen. nov.

Spelaeodelphax nexus – relict or pioneer?

With the information currently available, any assumption of the evolutionary origin of *Spelaeodelphax nexus* remains speculative. The genus is isolated, and the species shows a limited distribution. These observations seemingly suggest its status as a relict, and appears consistent with the climatic relict hypothesis, or CRH (e.g. Vandel 1964; Barr 1968). A similar situation, however, was present upon the description of the troglobiont genera *Ferricixius* Hoch & Ferreira, 2012 (Cixiidae) and *Iuiuia* Hoch & Ferreira, 2016 (Kinnaridae). Subsequently, however, epigean relatives of both genera were discovered (*Ferricixius*: see Santos et al. 2023; *Iuiuia*: unpublished data), rendering the assumption of an adaptive shift more likely. Under this scenario, known as adaptive shift hypothesis (ASH) as formulated by Howarth (1981), speciation occurs in parapatry as troglophilic populations undergo an adaptive shift to the cave environment in order to exploit novel food resources. The epigean planthopper fauna of the Neotropics, especially in a country as rich in insect biodiversity as Brazil, must be considered poorly investigated, and it cannot be excluded that close epigean relatives of *Spelaeodelphax nexus* may still be extant.

Conclusion

The discovery of *Spelaeodelphax nexus* increases the number of troglobiont planthopper species in Brazil from six to seven. The first planthopper species from Brazil was discovered just over a decade ago, and the new discovery highlights Brazil as a prominent location for the study of cave-dwelling planthoppers. In addition, the presence of this species also underlines the unique diversity and ecological complexity of biological communities in Brazilian cave environments and emphasizes the imperative need for the conservation and in-depth study of these ecosystems.

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